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# Factors Influencing Quality of Life Following Lower Limb Amputation for Peripheral Arterial Occlusive Disease: A systematic review of the literature

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## *Abstract*

*Purpose:* The majority of lower limb amputations (LLAs) are undertaken in people with Peripheral Arterial Occlusive Disease (PAOD), approximately 50% have diabetes. Quality of life is an important outcome in LLAs, little is known about what influences it, therefore how to improve it. The aim of this systematic review was to identify the factors that influence quality of life after LLA for PAOD.

*Methods:* MEDLINE, Embase, CINAHL, Psych Info, Web of science and Cochrane databases were searched to identify articles that quantitatively measured quality of life in those with a LLA for PAOD. Articles were quality assessed by two assessors, evidence tables summarised each article, and a narrative synthesis performed.

*Results:* Twelve articles were included. Study designs and outcome measures used varied. Quality assessment scores ranged from 36% to 92%. The ability to walk successfully with a prosthesis had the greatest positive impact on quality of life. A trans-femoral amputation was negatively associated with quality of life due to increased difficulty in walking with a prosthesis. Other factors such as older age, being male, longer time since amputation, level of social support, and presence of diabetes also negatively affected quality of life.

*Conclusions:* Being able to walk with a prosthesis is of primary importance to improve quality of life for people with lower limb amputation due to PAOD. In order to further understand and improve the quality of life of this population, there is a need for more prospective longitudinal studies, with a standardised outcome measure.

*Keywords:* Lower Limb Amputation (LLA), Quality of Life (QoL), Prosthesis, Walking, Trans-Femoral amputation (TFA), Trans-Tibial amputation (TTA) Peripheral Arterial Occlusive Disease (PAOD).

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## ***Introduction***

Peripheral arterial occlusive disease (PAOD), affects approximately 20% of adults over the age of 55 years in Europe and Northern America (1) and is a manifestation of systemic atherosclerosis, most commonly within the lower extremities (2). Approximately 6% of the UK population are living with diabetes which increases the risk of PAOD (3). PAOD can cause pain from ischaemia and infection of the lower limb and can be treated with wound management, orthotics or limb salvaging surgery (4). However, between 1-2% of those with the most severe form of PAOD will require a lower limb amputation (LLA) (1). Those with PAOD have limited mobility pre-amputation, attributable to the existence of co-morbidities such as ischaemic heart disease and cerebrovascular disease which often co-exist with PAOD. If diabetes is also present, many will have neuropathic, visual, renal and weight-related problems (3).

There are over 6000 primary LLAs per annum in the UK approximately 85% are due to PAOD (1, 5). Those undergoing a LLA due to PAOD are generally over 65 years old, and approximately 50% will have multi-morbidities (6). Life expectancy post LLA is only 2-5 years (7). This is predominately due to a six fold increase in mortality from coronary artery disease (8). It is therefore imperative that QoL post LLA is optimised to ensure that major surgery for PAOD is not a futile intervention.

Following LLA, the focus of rehabilitation is to optimise function, especially walking (9). Despite this, approximately 60% of people following LLA will be wheelchair-bound which may impede their physical capability, independence and thus their quality of life (6).

The surgical success of a LLA is often measured in terms of survival or receiving a prosthetic limb (10). Approximately 40% of those who undergo a LLA receive a prosthetic limb (6). Those who have a trans-tibial amputation (TTA) have a greater likelihood of walking with a

prosthesis than those with a trans-femoral (TFA) or through knee amputation (TKA) (11). The energy expenditure required to walk with a prosthesis following TFA is higher due to the loss of the knee joint (12). Consequently, only 26% of those with a TFA will receive a prosthesis, compared to 75% of those with a TTA (6). Successful outcome following a LLA should take into account the person's quality of life, a concept which has become increasingly more important in rehabilitation (13). Quality of life is defined as "an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns" (14). There are no validated quality of life outcome measures for those with a LLA; therefore generic quality of life outcome measures are used. These generic measures focus on the Function/Disability areas of the International Classification of Functioning and Disability Framework rather than the Contextual factors such as the environment.

A person who has a LLA for dysvascular reasons has a poorer quality of life compared to someone who has a LLA for other reasons such as trauma or tumour (15). To maximise rehabilitation outcomes an understanding of the factors that influence a person's quality of life following dysvascular LLA is essential for healthcare professionals. A previous literature review assessed quality of life in those with a LLA for all aetiologies, including trauma, tumour, orthopaedic complications and dysvascular causes (16). The majority of the 26 articles included had amputee populations of mixed aetiologies such as trauma or tumour (n=16), did not distinguish between upper and lower limb amputations (n=2) and compared major lower limb amputations to other surgeries (n=2) (16). To date, no systematic review has been undertaken on quality of life in those with LLA for PAOD. The aims of this systematic review were to report the quality of life of those with a LLA due to PAOD, and to identify the factors that influence quality of life after a major LLA due to PAOD.

## ***Methods***

### *Search Strategy*

A systematic literature review was undertaken in December 2015 using EBSCO and OVID which searched MEDLINE, CINAHL, Pubmed and PsychINFO databases. Web of Science and Cochrane databases were searched separately and all literature published from database inception to the end of 2015 were included. The search strategy included specific keywords and combined Medical Search History (MeSH) headings which were exploded for greater depth and the following terms were used: foot or feet, “lower limb”, knee, leg, amput\*, “above knee”, “below knee”, “lower extremity stumps”, “limb absence”, “limb loss”, “limb removal”, “quality of life”, quality of life, “Peripheral Vascular Disease”, “peripheral arterial occlusive disease”, “diabetes mellitus”, “diabetes”, “DM”, “type II diabetes”, “Activities of daily living”, “Physical and Rehabilitation medicine”, “Rehabilitation Centres”, Rehabilitation, “Mobility Limitation”, “Phantom Limb”, “Phantom Pain”. The use of Boolean terms “AND” and “OR” enhanced the search. Citations of relevant articles were also reviewed for possible inclusion.

### *Inclusion/Exclusion Criteria*

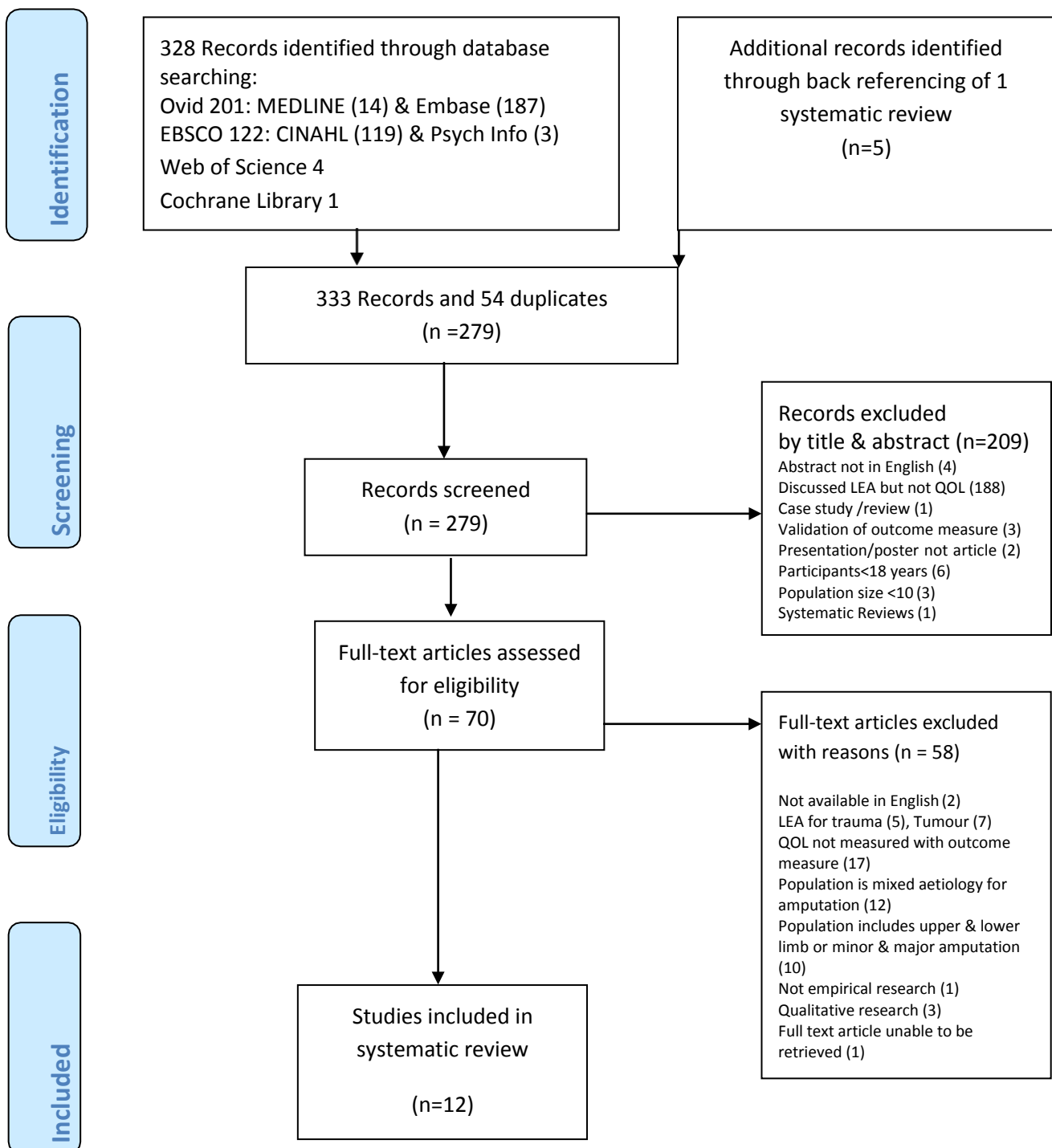
Articles were included if the entire amputee study population had a LLA due to PAOD; participants were 18 years old or over; the full text article was published in English; had a sample of more than 10 participants; reported the results of one or more quality of life outcome measures and was empirical research. Articles were excluded if they were; case-studies, reviews, editorial opinions, testimonies, biography/interviews, books, progress reports, conference abstracts or posters, discussion papers, guidelines, discussed other people’s quality of life, e.g. a carer’s or family member’s rather than a patient’s quality of life, and did not use an objective outcome measure which meant all qualitative studies were excluded. Also excluded were articles that were a development or validation of an outcome

measure to assess quality of life, if the populations studied were of mixed aetiology or if participants underwent an amputation for reasons other than PAOD.

The literature search produced 333 articles; 201 from OVID, 122 from EBSCO, 4 from Web of science, 1 from Cochrane and 5 from reference lists. Two systematic reviews were identified, one was not relevant (17) and the other provided back referencing of articles to include (16). Fifty four duplicate articles were removed. The titles of 279 articles were screened initially by one reviewer (FDS) which resulted in 209 being excluded. Then, two reviewers (FDS & EC) examined the abstracts of the remaining 70 articles and excluded a further 58 articles. This resulted in 12 full text articles for review and assessment (Figure 1).



**figure 1:** Schematic diagram of literature search when inclusion and exclusion criteria applied



### *Quality Assessment*

The included articles were scored using a quality assessment tool with 19 criteria, adapted from a previous systematic review (16). In order to bring the quality assessment in line with the STROBE guidelines (18) one further criterion was added; evidence of limitations, creating a 20 criteria tool (Figure 2) (18). These additional criteria assessed whether the authors had accounted for potential bias and discussed any limitations of their research. The maximum quality assessment score was 38 points, this was based on three sub-categories (i) the source population, (11%), (ii) study population characteristics, (42%) and (iii) methodological characteristics (47%) (16).

**figure 2:** Quality Assessment Criteria and scores used to rate the articles

Category	Criteria	Scores
(1) Source Population		
A	Description of source population	Not available (0) Ambiguous (1) Available (2)
B	Description of inclusion/ and or exclusion criteria	
(2) Study population characteristics		
C	Age	Not available( 0) Partially available (1) Available (2)
D	Gender	
E	Education	
F	Employment Status	
G	Marital Status	
H	Comorbidity	
I	Economic Status	
J	Data presentation of relevant O/M	
(3) Methodological characteristics		
K	Representative population	Not clear (0) Partially (1) Yes (2)
L	Study design/study type	Not clear( 0) Cross sectional design( 1) Retrospective / mixed design (2) Prospective design (3)
M	Population selection	Non randomised (0) Randomised / NA (1)
N	Instruments used	Non validated (0) Partially validated (1) Validated (2)
O	Statistical methods for O/M	Non appropriate( 0) Partially appropriate (1) Appropriate (2)
P	Control for confounding variables	Not considered( 0) Partially considered (1) Fully considered (2)
Q	Response Rate vs. Drop outs	<60%/not mentioned( 0) 60-80% (1) >80% (2)/NA (2)
R	Characteristics of drop outs	Not reported( 0) Reported (1)/NA (1)
S	Relevant O/M	Not well defined( 0) Well defined (1)
T	Limitations	Not considered (0) Partially considered (1) Fully considered (2)

\*Quality assessment tool adapted with STROBE tool from Sinha et al (1, 2)

Each article was independently scored by two of three assessors (FDS, EC and LP), and when agreement could not be met, the third assessor was consulted to ensure consensus was reached. A pilot assessment was conducted where all three reviewers read one article independently and scored it, then met to discuss the scoring and agreement was achieved. From this successful pilot, the remainder of the articles were scored with two assessors.

## ***Results***

The twelve studies that were eligible for inclusion are presented in table 1. This highlights each study's aims, population, QoL outcome measure and findings; these were grouped by methodological design (Table 1).

**table 1:** Evidence of Literature

Author, Year, Design & Quality Assessment Score	Aim of Study	Sample population	Time Point(s)	QOL Outcome Measures(s)	Main findings
<b>Prospective Design</b>					
(2) Buijck et al (2012) <b>QA=47%</b>	To determine what affects QOL in the home environment following LLA after a period of in-patient rehabilitation in the elderly population.	n=27 people: Mean Age 75 years Major LLA's 8TFA, 4 TKA & 15 TTA. All elderly and discharged from in-patient care to home.	3 months after in-patient discharge	<ul style="list-style-type: none"> <li>Research &amp; Development Corporation Measure of Quality Of Life (RAND-36)</li> </ul>	<p>8 were fitted with a prosthesis for cosmetic purposes and 11 for mobility. Of the 11 only 2 were mobile without walking aids.</p> <p><b>Mean QOL score ranged from 22-87, and low QOL (on physical function) was correlated positively to poor functional ambulation score.</b></p> <p>High QOL scores were associated with low scores for depression and neuropsychiatric symptoms.</p> <p>Pain was not associated with any factors</p>
(5) Fortington et al (2013) <b>QA=71%</b>	To describe changes in HRQOL from amputation to 18 months post-amp in lower limb amputees and compare this to a normal population.	n=82 Mean Age 67.8 years ( $\pm 13$ ) LLA, 30 TFA/TKA & 52 TTA, @ 18 months n=42 All were mobile with a prosthesis @ 18 months	At LLA & 6 & 18 months post LLA	<ul style="list-style-type: none"> <li>Research &amp; Development Corporation Measure of Quality Of Life (RAND-36 Dutch version)</li> </ul>	<p>TK &amp; TF level of amputations were linked to a significantly lower level of physical function than TTA.</p> <p><b>The ability to walk was related to improved social function &amp; higher QOL</b></p> <p>Most change in QOL occurred in first 6 months post LLA</p> <p>Age was a significant factor in HRQOL in physical function</p> <p>Lower QOL in LLAs was reported in all domains compared to population norms.</p>
(8) Norvell et al (2011) <b>QA=92%</b>	Examine factors associated with mobility success	n=87 Mean Age 62 years at time of LLA and (TMA=27,	At LLA & 12 months post LLA	<ul style="list-style-type: none"> <li>Satisfaction With Life Scale (SWLS)</li> </ul>	<p>Decline in mobility in all groups over time from pre-LLA, however this was greatest in TFA's</p> <p>If mobility success was achieved then participants were more likely to have improved satisfaction with life</p>

	during first year following 1 <sup>st</sup> major unilateral LLA +/- DM.	52=TTA,8-TFA) n=75 at follow-up (TMA=26, TTA=42,TFA=7)			Although 50% of the group reported low to moderate levels of mobility this was associated with mobility satisfaction.
<b>Mixed Design</b>					
(7) Neill et al (2008) <b>QA=68%</b>	To examine long term outcome; prosthetics and QOL, after bilateral trans-tibial amputation.	n=82 at baseline Mean Age 68.5 years and n=34 followed up at 3.7 years post amputation	~3.7 years post LLA	<ul style="list-style-type: none"> <li>• Houghton</li> <li>• SF-12</li> <li>• Qualitative measures of ADL</li> </ul>	85% of those who survived at 3.7 years were still mobile on their prosthetics with higher SF-12 scores in the mental health aspect than the physical aspect. Those living alone reported better mental health and were more independent than those who lived with others.
<b>Cross sectional Design</b>					
(1) Abdelgadir et al (2009) <b>QA=68%</b>	To compare two groups of people with differing durations of diabetes, one group had lower limb amputations (LLA).	n=60 major LLAs (44 TTA & 16 TFA) Mean Age 57.4 years ( $\pm 10.5$ ) compared to 60 people without LLAs, all of whom had DM.	~5.3 Years since LLA	<ul style="list-style-type: none"> <li>• Medical Outcome Study questionnaire (MOS)</li> <li>• Sense Of Coherence scale (SOC)</li> </ul>	<p><b><i>Reduced mobility in LLAs was highly correlated to the role physical aspect of the QOL scores</i></b></p> <p>Increased duration of diabetes, worsening symptoms and undergoing an LLA were associated with poor QOL Longer time since LLA was associated with lower QOL compared to more recent LLA QOL was greatest in those with improved family satisfaction and better sleep</p>
(3) Cox et al (2011) <b>QA=58%</b>	To determine QOL and functional independence of diabetic amputees.	n= 87 (64 TTA & 23 TFA) Mean Age 62 years ( $\pm 9.9$ ) , all with DM	From 1-3 years since LLA	<ul style="list-style-type: none"> <li>• World Health Organisation Quality of Life Scale (WHO-QOL-BREF)</li> </ul>	<p>Those with a TTA recorded improved QOL and functional independence compared to those with a TFA Females had a higher QOL in all 4 domains <b><i>Positive correlation was found between functional independence and QOL in all participants</i></b></p>

(4) Deans et al (2008) <b>QA=63%</b>	Investigate the link between physical activity and associated QOL	n=25 Mean Age 66 years of a possible 75 unilateral LLAs (22 TTA & 3 TFA) who were fitted with a prosthesis.	Discharged from out-patient prosthetics for > 2 years from LLA	<ul style="list-style-type: none"> <li>Trinity Amputee and Prosthetic Experience Scale (TAPES)</li> <li>World Health Organisation Quality of Life Scale (WHO-QOL BREF)</li> </ul>	<p><b>Correlation between functional score on the TAPES and the physical function aspect of the QOL measure.</b></p> <p>Correlation between social aspects of both scales suggesting that LLAs place more emphasis on their social status and interactions than on physical fitness</p>
(6) Harness et al (2001) <b>QA=60%</b>	To assess prosthesis related QOL	60 unilateral TTA Mean Age 65.9 years ( $\pm 1.4$ )	Minimum of 6 months prosthetic use (median 24 months)	<ul style="list-style-type: none"> <li>Prosthetic Evaluation Questionnaire (PEQ)</li> </ul>	<p><b>Social burden correlated positively with the ability to mobilise with prosthesis</b></p> <p>Satisfaction correlated with less pain and the ability to mobilise</p> <p>Weak association between pain and residual limb health and ability to mobilise with a prosthesis</p>
(9) Pell et al (1993) <b>QA=63%</b>	To assess the effect of LLA on QOL and compare this to population norms	n=130 Median Age 73 years (86 TTA & 44 TFA) 42% were mobile with their prosthesis	Median of 38 months since time of LLA	<ul style="list-style-type: none"> <li>Nottingham Health Profile (NHP)</li> </ul>	<p>Those with a LLA have a lower QOL than population norms.</p> <p><b>QOL is directly linked to mobility</b></p> <p>Isolation is more pronounced in those with a LLA despite social situation even when compared to controls who lived alone</p>
(10) Remes et al (2010) <b>QA=79%</b>	To assess QOL of Amputees with PAD	59 unilateral amputees (13 TTA, 28 TFA, 18 Bilateral) Mean Age 75.2 years ( $\pm 10.7$ )	2 years after LLA	<ul style="list-style-type: none"> <li>Research &amp; Development Corporation Measure of Quality Of Life (RAND-36)</li> <li>Six Item Brief Social Support Questionnaire (SSQ6)</li> <li>Geriatric Depression Scale</li> </ul>	<p>Home dwelling amputees had good QOL compared to those in institutions and those who could not walk</p> <p>Mini mental score lower in those with LLA</p> <p>More co-morbidities in those with LLA</p> <p><b>Reduced mobility was an independent factor in poor QOL</b></p> <p>Similar health satisfaction &amp; social support between controls &amp; LLAs</p> <p>More depression in those who were in care homes or could not mobilise</p> <p>Although LLAs had reduced physical function they had larger social support structure than those without an</p>

				(GDS) <ul style="list-style-type: none"> <li>15D Health Related Quality Of Life (15D HRQOL)</li> <li>Satisfaction With Life Scale (SWLS)</li> </ul>	LLA
(11) Tennvall et al (2000) <b>QA=68%</b>	Compare Health Related QOL in people with DM who attended foot clinic	n=26 major LLAs (level not stated). Mean Age 67 years  A total of 310 people were surveyed, the remainder had foot ulcers or minor amputations Response Rate of 70%	1-3 years post LLA	<ul style="list-style-type: none"> <li>Euroqol Quality of Life Questionnaire (EQ-5D-5L Swedish version)</li> </ul>	People who had major LLA had lower QOL compared to those with current foot ulcer or minor LLA People who had minor LLA had higher QOL than those with no LLA and a current foot ulcer
(12) Thompson et al (1995) <b>QA=37%</b>	To compare distal bypass surgery with major LLA in terms of QOL	n=24 LLA Median Age 69 years compared to n=48 bypass	Retrospective but no date given	A self Assessment QOL including <ul style="list-style-type: none"> <li>Hospital Anxiety &amp; Depression Scale (HADS)</li> <li>9 point scale of social function</li> <li>4 point mobility scale</li> </ul>	Bypass group had lower levels of depression, impairment and greater mobility than LLA group in terms of QOL QOL was lower overall for those with a LLA indifferent of whether bypass had failed or not.

\*Abbreviations: PAOD, LLA, TTA, TKA, TFA, TMA, DM, QoL, QA



### *Scoring of Quality Assessment*

Quality Assessment scores ranged from 36% to 92%. Reviewers reached agreement of all final scores. The majority of the included articles were of good quality, with ten of the twelve articles scoring more than 50%. Analysed by subcategories, ten of the twelve articles achieved the maximum score for source population, however only four articles achieved a score over 50% for study population characteristics. The methodological characteristics subcategory had higher quality scores; with the majority (11 of 12) scoring over 60% (Table 2).

**table 2:** Quality Assessment Scores

		Source Population				Study Population Characteristics										Methodological Characteristics												Quality Scores	
		A	B	Total	%	C	D	E	F	G	H	I	J	Total	%	K	L	M	N	O	P	Q	R	S	T	Total	%	Over all Total	%
1	Abdelgadir (2009)	2	2	4	<b>10</b>	2	2	1	0	0	0	0	2	7	<b>18</b>	2	1	1	2	2	1	2	1	1	2	15	<b>40</b>	26	<b>68</b>
2	Buijck (2012)	2	0	2	<b>5</b>	1	2	0	0	0	0	0	2	5	<b>13</b>	2	3	1	2	2	0	0	0	1	0	11	<b>29</b>	18	<b>47</b>
3	Cox (2011)	2	2	4	<b>10</b>	2	2	0	0	0	0	0	2	6	<b>16</b>	1	1	1	2	2	0	2	1	1	1	12	<b>32</b>	22	<b>58</b>
4	Deans (2008)	2	2	4	<b>10</b>	1	2	2	0	2	0	0	2	9	<b>24</b>	2	1	1	2	2	0	0	0	1	2	11	<b>29</b>	24	<b>63</b>
5	Fortington (2013)	2	2	4	<b>10</b>	2	2	0	0	0	0	0	2	6	<b>16</b>	2	3	1	2	2	2	1	1	1	2	17	<b>45</b>	27	<b>71</b>
6	Harness (2001)	2	2	4	<b>10</b>	2	2	0	0	0	1	0	2	7	<b>18</b>	2	1	1	2	2	0	2	1	1	0	12	<b>32</b>	23	<b>60</b>
7	Neill (2008)	2	2	4	<b>10</b>	2	2	0	0	0	2	0	2	8	<b>21</b>	2	2	1	1	2	1	2	0	1	2	14	<b>37</b>	26	<b>68</b>
8	Norvell (2011)	2	2	4	<b>10</b>	2	2	2	2	2	2	2	2	16	<b>42</b>	1	3	1	1	2	2	2	0	1	2	15	<b>40</b>	35	<b>92</b>
9	Pell (1993)	2	2	4	<b>10</b>	1	2	0	0	1	0	0	2	6	<b>16</b>	2	1	1	2	2	2	2	1	1	0	14	<b>37</b>	24	<b>63</b>
10	Remes (2010)	2	1	3	<b>8</b>	2	2	2	0	2	2	0	2	12	<b>31</b>	2	1	1	2	2	1	2	1	1	2	15	<b>40</b>	30	<b>79</b>
11	Tennvall (2000)	2	2	4	<b>10</b>	2	2	0	0	0	1	0	2	7	<b>18</b>	2	1	1	2	2	2	1	1	1	2	15	<b>40</b>	26	<b>68</b>
12	Thompson (1995)	2	2	4	<b>10</b>	1	0	0	0	0	0	0	1	2	<b>5</b>	1	1	1	1	2	0	1	1	0	0	8	<b>21</b>	14	<b>36</b>

### *Sample Populations*

There was large variation in sample size, sampling techniques and comparator groups throughout the 12 studies. Sample sizes ranged from n=24 (19) to n=130 (20). Sampling techniques included purposive (19-27), convenience (28, 29) and random sampling (30). Comparison groups included age and gender matched controls (20, 23, 27); those with limb salvaging surgery (19); and those with foot ulcers (22).

### *Study Designs*

Study designs were cross sectional (n=8) (19-23, 26, 27, 30), prospective (n=3) (24, 25, 29) and mixed methods (n=1) (28). The time points chosen to assess quality of life ranged from 3 months after in-patient discharge (29) to 5.3 years after LLA (27). The length of time between outcome measurements in prospective longitudinal studies also varied from date of LLA, 6 and 18 months post LLA (25) to 6 weeks and 12 months post LLA (24).

### *Outcome Measures*

A variety of generic quality of life outcome measures were used across the studies: the Research & Development Corporation measure of quality of life (RAND-36) (n=3) (23, 25, 29); the World Health Organisation quality of life scale (WHOQOLBREF) (n=2) (21, 26) (n=2); the 12 item short form survey (SF12)(n=1) (28) and the EuroQuality of life (EQ-5D) (n=1) (22).. Although none of these measures have been validated for use with the LLA population, Sinha et al (2014) reported high internal consistency for the Short Form-36 in the LLA population(31) The same authors found a significant correlation between the Trinity Amputation and Prosthetic Experience Scale (TAPES) and the Physical and Mental component summaries of the Short Form 36 (SF-36) QoL measure in the LLA population (31). The Prosthetic Evaluation Questionnaire (PEQ) (n=1) (30) is specific to those who have

a prosthesis after LLA. Other scales such as the Satisfaction With Life Scale (SWLS) (n=2), (24); Sense of coherence scale (n=1) (27); Nottingham health profile (n=1) (20); and a 9-point scale of social function (n=1) (19) were also used.

Ten studies used a single measure to assess quality of life (20-22, 24-30), whereas one study used four separate measures (23). Seven studies measured quality of life alongside other factors such as physical function, depression, social support, prosthetic use and change in walking (19, 21, 23, 24, 26, 28, 29).

### ***Factors influencing quality of life***

#### *Walking Ability and use of prosthesis*

Walking with a prosthesis was the most notable factor that influenced QoL, and was reported by all twelve studies. The other factors that were identified that influenced QoL were gender, age, diabetes and family support (Table 2).

When comparing quality of life of people after LLA to age and gender matched controls, after controlling for social isolation and emotional distress, the ability to walk was still found to significantly influence quality of life (20, 27). Norvell et al (2011) suggested that even small amounts of walking resulted in greater quality of life compared to being unable to walk (24). In addition, Deans and colleagues (2008) suggested that the association between quality of life and walking was due to the positive influence of walking with a prosthesis on social interaction, rather than improving physical fitness (26).

Two cross-sectional studies compared those with a LLA to people with active foot ulcers (22) and bypass graft (limb salvaging surgery) (19). Both studies concluded that the quality of life of those with a LLA was significantly poorer than those with active foot disease or surgery. Those who underwent a LLA had higher levels of depression and were less mobile than those

who underwent a bypass graft (19). Mobility was self-reported on a four point scale and those with a LLA were significantly less mobile than those with revascularisation; however no information about prosthetic use or distances covered was given. Although the results are as expected, this article was a retrospective study with a relatively small number of those with LLA (n=26) compared to those with a bypass graft (n=86) and the study's quality assessment score was low (Table 2).

### *Level of LLA*

Two studies of prospective design examined the effect of level of LLA on QoL (24, 25), both achieving high quality assessment scores (Table 2). Those with a TTA reported better quality of life, compared to those with a TFA (25). This was due to improved walking ability and thus greater social function in those who had a TTA. A decline in quality of life and walking was observed over 12 months after LLA in all participants with LLA regardless of level, (25) however, this decline in quality of life was greatest in those with a TFA (24). In one study of people with unilateral TTA a strong association was found between quality of life and the ability to walk (n=60) (30), however the sample all received prosthetic rehabilitation and were therefore more likely to be mobile.

### *Age, Co-morbidities & Gender*

There was a strong association between being over 65 years of age at the time of LLA and reduced ability to walk, which ultimately had a detrimental effect on quality of life (24, 25). With increasing age there was a higher incidence of co-morbid disease (25) which may have affected quality of life directly or indirectly through the influence of the co-morbid conditions on walking ability.

The presence of diabetes was associated with a lower quality of life following LLA. Furthermore, the longer the duration of diabetes and its associated secondary complications, the poorer the quality of life (27). Other co-morbidities such as hypertension, alcohol dependence, anxiety and depression are reported to negatively influence quality of life (24). Two studies found that gender influences quality of life with women having higher quality of life following LLA (21, 27) especially in those under 60 years old.

### *Social Situation*

Living at home and being able to walk, was positively associated with quality of life (23). Poor quality of life and the presence of depressive symptoms were more prevalent in those living in a care home or in those who were wheelchair-bound within their home environment (23). Neill et al (2008) found that those who had bilateral TTA's and lived alone scored higher on the mental health aspect of quality of life and higher on the activities of daily living on the Frenchay Activities Index, than those who lived with family (28). The authors also suggested that poorer quality of life was attributed to social isolation, 24% of people were housebound, however social isolation was reported to be present even if participants did not live alone (20).

### *Discussion*

The aims of this systematic review were to identify the factors that influence quality of life after LLA for PAOD. Our findings show that, the ability to walk with a prosthesis had the strongest influence on quality of life. Many factors affect the ability to walk, with a prosthesis such as level of LLA, co-morbid diseases, psychological motivation, living situation and social function. Although there is general agreement that those with a LLA have poorer quality of life compared to their healthy peers; walking ability was the central influencing

factor, which then determined the ability to live independently and participate in social activities which also impacted of quality of life.

Our review concurs with some of the findings of Sinha et al (2011) who also found that limited walking ability negatively influences quality of life in those with a LLA (16). Furthermore, our review found that the ability to participate socially, perform activities of daily living and live independently influences the quality of life of a person with a LLA due to PAOD. The age range of the populations studied in this review was from 56 to 75 years old. Of all the studies included in this review, only one study reported that quality of life declined with increasing age; specifically over 65 years old. Our review is novel as it focuses solely on those who have a LLA due to PAOD as opposed to previous reviews which have examined heterogeneous groups of those with amputations. LLA due to PAOD are the most common and have the greatest impact on health resources.

Factors such as advancing age and co-morbidities, notably diabetes, negatively influence the probability of successfully walking with a prosthesis and therefore quality of life (24, 25, 27). The majority of those with a LLA due to PAOD are over 65 years old and approximately half will have diabetes. The presence of arterial disease in other organs adds to the co-morbid burden of this patient group, compounded by walking ability which may be impaired prior to LLA (6), these factors reduce their life expectancy and ability to walk with a prosthesis . One solution to improving the QoL of non-prosthetic users may be extending rehabilitation and integration with prosthetic users to allow for improvements in morale and social integration (20). Quality of life was greater in those with a TTA compared to a TFA. Those with distal amputations e.g. TTA, are more likely to have successful prosthetic management, less likely to need walking aids and more likely to engage in meaningful vocational and social activities (11). Hagberg et al (2006) concluded that those with a TFA had poorer quality of life, than those with a TTA, as they required a higher level of energy expenditure to walk, due to the

loss of the knee joint (12). In addition, it is possible that, lower mood and higher psychological burden may reduce the inclination to participate in rehabilitation which lowers the successful use of a prosthesis.

Two studies in this review examined the gender differences in quality of life (21, 27). Improved quality of life was reported in females, compared to males, and was attributed to their higher levels of physical function. These findings conflict with previous literature, in which males were found to have greater quality of life (16). However the review by Sinha et al (2011) included those with LLAs for non-vascular causes. Therefore it is possible that quality of life following a LLA may be greater in females when it is due to PAOD and improved in males when the LLA is due to trauma or tumour. Further research is warranted to examine these gender differences.

Although there were conflicting results regarding family support and its impact on quality of life, those who live alone may be more capable, both cognitively and physically, and therefore have a better quality of life (32). Mac Neill et al (2008) also suggested a cause and effect relationship between quality of life and living alone (32). More specifically, those who lived alone were more able to perform activities of daily living independently; a third engaging in social outings on a weekly basis. Consequently, they had better mental health as they felt less burdensome and relied less on others. Conversely, two studies suggested that living with family was associated with better quality of life in comparison to those who lived alone (20, 27). Although these studies focussed on living with family, the rating of good quality of life may be replicated in a supportive environment such as residential or assisted living complex.

There are no validated quality of life outcome measures available for the LLA population, accommodating both wheelchair and prosthetic mobility. The TAPES was used in one study,



however this only assesses the function of prosthetic users (26). The Prosthetic Evaluation Questionnaire (PEQ), which has a sub-section that measures quality of life, is the only outcome measure that has been validated for use in those with a LLA. Despite this, it is only relevant for those who receive a prosthesis and was only used in one study included within this review (30). Developing and validating a quality of life outcome measure for this population is imperative to allow for more rigorous future longitudinal studies, systematic reviews and meta-analyses.

This review has demonstrated that being able to walk with a prosthesis is the main factor affecting quality of life after a LLA for PAOD. A number of factors such as age, level of amputation, and the presence of co-morbidities also affect quality of life in those with PAOD, but are not modifiable. It is therefore important that rehabilitation focus on modifiable factors, particularly with regards walking. Furthermore LLAs due to non-vascular aetiologies have benefitted from advances in prosthetic technologies and access to rehabilitation (33, 34). The improved technology may benefit amputees in prosthetic comfort, pain relief and energy conservation improving walking ability following LLA..

### *Study Limitations*

This review was limited to studies published in English. It was also limited by the heterogeneity of the study designs included. Due to the variety of outcome measures used it was not possible to conduct a meta-analysis. Studies using qualitative methodologies were excluded from the review however they may have added context to the factors that influence quality of life.

### *Conclusions*

This review is novel in its focus on those with a LLA due to PAOD and as such has identified the factors that influence quality of life in this population. Walking is the main factor that

influences quality of life following LLA and as such rehabilitation should focus on gait re-education with a prosthesis. In order to improve the quality of life there is a need for more prospective longitudinal studies with a standardised outcome measure which can examine the possible change in quality of life over time.

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